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DOI: https://doi.org/10.1257/aer.20140259

American Economic Review 2016, 106(11): 3367–3400
http://dx.doi.org/10.1257/aer.20140259

Leverage and Beliefs: Personal Experience and Risk-Taking in Margin Lending[†]

By Peter Koudijs and Hans-Joachim Voth*

What determines risk-bearing capacity and the amount of leverage in financial markets? Using unique archival data on collateralized lending, we show that personal experience can affect individual risk-taking and aggregate leverage. When an investor syndicate speculating in Amsterdam in 1772 went bankrupt, many lenders were exposed. In the end, none of them actually lost money. Nonetheless, only those at risk of losing money changed their behavior markedly; they lent with much higher haircuts. The rest continued largely as before. The differential change is remarkable since the distress was public knowledge. Overall leverage in the Amsterdam stock market declined as a result. (*JEL* D12, D14, D83, G11, G21)

Leverage in financial markets is not constant over time. Lending is typically procyclical: high and increasing in good times, and much lower when asset prices fall (Adrian and Shin 2010). For example, when the stock market crashed after Lehman's bankruptcy in 2008, haircuts[1] increased sharply and the volume of collateralized lending collapsed (Gorton and Metrick 2012; Krishnamurthy, Nagel, and Orlov 2014). Procyclical leverage cycles affect the risk-bearing capacity of financial intermediaries and can contribute to large changes in asset prices (He and Krishnamurthy 2013).[2] The source of these important changes is less clear.[3]

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[†]Go to http://dx.doi.org/10.1257/aer.20140259 to visit the article page for additional materials and author disclosure statement(s).

[1]The difference between the asset's market value and the loan amount, the reciprocal of leverage.

[2]Resulting changes in asset prices are observationally equivalent to changes in risk aversion, which contribute importantly to price swings in the aggregate (Campbell and Cochrane 1999; Cochrane 2011).

[3]Regulatory and technical constraints—such as value-at-risk (VAR) limits—can help to rationalize large shifts in credit provided to financial markets (Adrian and Shin 2010; Geanakoplos 2010). Several contributions to the literature on procyclical leverage argue that volatility of asset prices is greater in bad states of the world (Brunnermeier and Pedersen 2005; Vayanos 2004). Fostel and Geanakoplos (2008) rationalize this finding in a setting with heterogeneous agents.

We argue that changes in beliefs on the part of lenders can explain shifts in market-wide leverage, and that personal experience is an important determinant of these changes. Our argument is related to a literature examining the effects of individual experience on behavior in financial markets. Malmendier and Nagel (2011) demonstrate that individuals who lived through the Great Depression invested systematically less in equities, even after controlling for age, gender, and income. Guiso, Sapienza, and Zingales (2013) show that during the recent financial crisis, Italian investors became markedly more risk averse. In an experimental setting, inducing fear can reduce risk-taking (Cohn et al. 2015). Key challenges in this literature are to show that changes in attitudes can affect aggregate risk-bearing capacity, even in markets with sophisticated participants, and that changes in behavior are not simply a reflection of lower wealth.[4]

In this paper, we show that adverse experiences can change beliefs, leading to large increases in haircuts in a sophisticated and liquid loan market, creating procyclical leverage in the aggregate. Importantly, lenders' personal willingness to take risks declined even without individual losses. Using hand-collected data from notary archives, we focus on margin loans in the eighteenth century Amsterdam stock market. This setting has two key advantages. First, loans were collateralized with securities that had readily observed market prices, and leverage can easily be measured by the haircuts imposed. Second, because loan contracts were negotiated in an over-the-counter (OTC) market, we can identify the impact of differences in lenders' personal experience on the cross section of haircuts. We focus on one particular episode of financial distress around Christmas 1772. The Seppenwolde syndicate speculated in East India Company stock. Lenders exposed to the syndicate were at *risk* of significant financial losses, but escaped unharmed. Uncertainty was resolved within a matter of weeks. Financiers who had lent to the syndicate before became more conservative. Before the crisis, collateral requirements of exposed lenders were indistinguishable from the rest of the market. Suddenly, after the Seppenwolde bankruptcy, lenders involved with the syndicate only extended loans with markedly higher haircuts (panel A of Figure 1). Their average down payment rose from 20 to almost 30 percent within six months. Other lenders—not at risk of personal losses—conducted business as usual.

Major lenders to the stricken syndicate changed their behavior, influencing aggregate market conditions. The tightening of collateral requirements in the Amsterdam secured lending market after Christmas 1772 is fully explained by former financiers of the syndicate lending with higher haircuts. At the same time, interest rates on loans extended by both groups of lenders remained unchanged (panel B of Figure 1), and exposed lenders did not exit the sample at a higher rate. Other margins of adjustment point toward lower risk-taking: affected lenders reduced their volume of margin lending overall and started to lend to less risky borrowers. Importantly, although haircuts of exposed and non-exposed lenders eventually began to converge (after a year), the effect remains visible for as long as we have data: a one-off, large shock changed the behavior of major players substantially and for an extended period.

[4] Guiso, Sapienza, and Zingales (2013) find no correlation with wealth, consumption patterns, or other sources of risk. Brunnermeier and Nagel (2008) conclude that wealth fluctuations only have minor effects on risk tolerance.

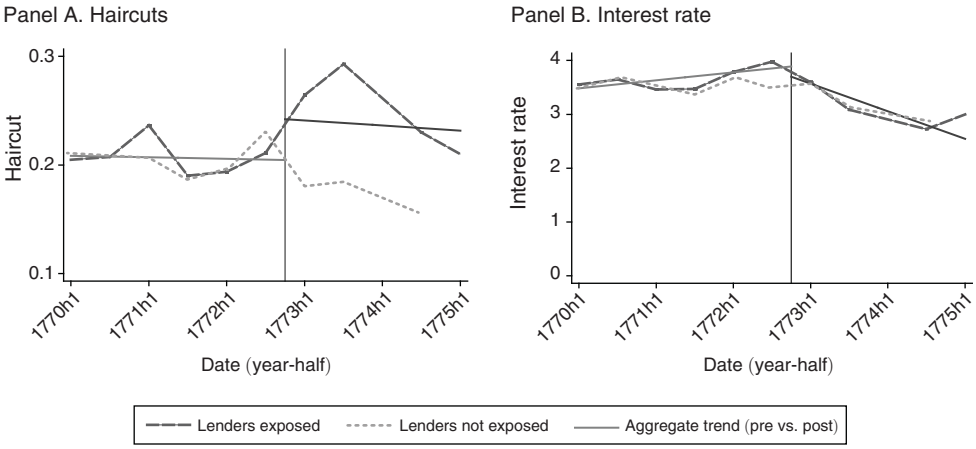

FIGURE 1. HAIRCUTS OVER TIME (*Half-Yearly Averages*)

Notes: Panel A presents the average haircuts demanded by exposed and non-exposed lenders for every year-half between 1770h1 and 1775h1 (when our data end). Averages are weighed by the size of the loan transactions (face value of collateral). Panel B shows the average interest rates demanded by exposed and non-exposed lenders for every year-half between 1770h1 and 1775h1 (when our data end). Averages are also weighed by the size of the loans.

Why did borrowers not simply shift toward lenders who were not affected by the Seppenwolde bankruptcy? There was no centralized exchange for loans and borrowers had to search for potential lenders. Who they matched with depended on who happened to have liquidity available at the right moment. Our identification therefore relies on the accidental timing of liquidity needs. After Christmas 1772, unaffected lenders were generally in short supply, and borrowers had to settle for higher haircuts if their funding need happened to coincide with available funds in the hands of an exposed lender. In other words, the differential response of haircuts is observable because of the search-and-matching process between lenders and borrowers. We rationalize these changes in an OTC market version of Geanakoplos' (2003) model of collateralized lending, emphasizing investor heterogeneity. Optimists borrow to buy a risky asset while pessimists lend. In equilibrium, speculation in risky securities is financed by contracts involving minimal risk to the lenders; the cost of risky contracts would be prohibitive from the perspective of the borrower.[5] Fluctuations in haircuts reflect changes in the level of disagreement between investors about the payoff of an asset or shifts in investor characteristics, such as the share of optimists and pessimists.[6] By only affecting one set of investors—and their lenders—the distress in the Amsterdam stock market in 1772/1773 increased lender heterogeneity. Having only narrowly escaped from losses, affected lenders became more pessimistic; consistent with Geanakoplos (2003), they demanded higher haircuts. In our

[5] In the Geanakoplos model, agents with more optimistic beliefs want to lever up to invest in the asset. Pessimistic agents do not want to hold the asset directly, but are willing to lend to the optimists on the collateral of the asset. The equilibrium contract turns out to be risk free. The haircut is set such that even in the worst possible state of the world lenders are fully repaid. From a borrower's perspective it is prohibitively expensive to contract a risky loan with a lower haircut—he expects to always pay a high risk premium, even in states of the world where the more pessimistic lender expects him to default.

[6] Simsek (2013) uses a Geanakoplos-style model to analyze the effects of more general types of disagreement.

historical setting, personal experience changed behavior, generating procyclical leverage in the aggregate.

We can rule out several alternative interpretations: losses among intermediaries, which may have played an important role in the recent crisis (Brunnermeier and Pedersen 2005; Adrian and Shin 2010), were unimportant.[7] Also, the price fall was largely exogenous, driven by the arrival of negative news about fundamentals in Bengal. Lenders at risk of losing money then reduced the riskiness of their lending by raising collateral requirements. Despite the decline in effective funding for speculators, the price decline was limited and reversed quickly; no loss spirals followed the sharp shift in haircuts. Because lenders did not suffer any losses, higher haircuts cannot reflect an increase in (wealth-dependent) risk aversion. Finally, increases in haircuts were not driven by regulatory constraints, such as VAR limits, which can drive fire sales (Brunnermeier and Pedersen 2009).

Our research contributes to the literature on asset prices and heterogeneous beliefs more generally. Differences in beliefs can be important for asset pricing (Miller 1977; Harrison and Kreps 1978; Jarrow 1980; Hong and Stein 2007). Where these differences come from is an area of active research. Agents may have access to different information sets (Brunnermeier 2001; Hong, Kubik, and Stein 2005a)[8] or have different beliefs as a result of their own experiences. The latter is often called reinforcement learning (Camerer and Ho 1999; Erev and Roth 1998). A number of contributions look at the impact of experience on decision making in financial markets (Choi et al. 2009; Greenwood and Nagel 2009; Kaustia and Knüpfer 2008; and Vissing-Jorgenson 2003).[9] Malmendier and Nagel (2011, 2016) show that both the Great Depression and high inflation in the 1970s influenced expectations and behavior. Guiso, Sapienza, and Zingales (2013) argue that experiencing a financial crisis can induce a big change in risk appetite. In the same spirit, Heath and Tversky (1991) conclude that the willingness to take risks declines sharply with distrust in one's own judgment. Murfin (2012) shows that banks impose stricter loan covenants when they suffer losses on their loan portfolios. More generally, our work connects with research on the determinants of attitudes and beliefs.[10]

Our paper also contributes to the literature using historical data on haircuts as a measure of expectations. Rappoport and White (1994) argue that increasing margin requirements in the run-up to the 1929 crash on the New York Stock Exchange reflected growing worries about a coming crash. Temin and Voth (2004) argue that haircuts in lending against stock during the South Sea bubble suggest that investors were "riding" the bubble. Schnabel and Shin (2004) argue that leverage cycles created contagion and falling asset prices in the Amsterdam financial crisis of 1763 (Quinn and Roberds 2015).

[7] For a historical example, cf. Schnabel and Shin (2004).

[8] Social networks can shape investor attitudes (Hong, Kubik, and Stein 2005b) and attitudes more generally (Acemoglu and Jackson 2015); social capital can boost trust in the stock market (Guiso, Sapienza, and Zingales 2008a).

[9] A formal model of experience-based belief formation is Piketty (1995).

[10] Graham and Narasimhan (2004) and Malmendier, Tate, and Yan (2011) find that corporate managers who were born before the Great Depression make more conservative capital structure decisions. The latter authors and Benmelech and Frydman (2015) also argue that CEOs with a military background act systematically differently as leaders of firms. Personal experience may also be a prime determinant of differences in beliefs. For cultural persistence and change more broadly, cf. Alesina and Fuchs-Schündeln (2007) and Guiso, Sapienza, and Zingales (2008b).

We proceed as follows. Section I discusses the historical background. Section II summarizes the key features of our model of secured lending. Section III describes the data. Section IV presents the main empirical results, and Section V considers a variety of extensions and robustness checks. Section VI concludes. Additional material is in online Appendices A through G; references to figures and tables starting with a corresponding letter can be found there.

I. Historical Background

We first describe the nature of collateralized lending in eighteenth century Amsterdam. We briefly explain the East India Company's situation, and summarize evidence on the investment syndicate's bankruptcy. Finally, we describe how the authorities dealt with the crisis.

A. *Collateralized Lending in Eighteenth-Century Amsterdam*

The market for secured lending in eighteenth century Amsterdam resembles the market for margin loans in modern-day markets. It can be traced back to the early seventeenth century (Gelderblom and Jonker 2004). By the 1640s, lending against stock had developed into a mature, standardized market (Petram 2014). From the eighteenth century onward, English securities were used as collateral, including British East India Company stock (EIC). Three features are important. First, lending took place largely without intermediaries. Instead, borrowers and lenders interacted directly. Second, there was no centralized loan market where uniform lending terms were set and the market cleared. Rather, borrowers and lenders had to find each other through search. Third, loans were renewable and of standardized length; most loans were renewed or terminated after six months (with few exceptions).

Online Appendix A provides the transcript of a typical contract. A borrower received money from the lender and in return posted collateral. Ownership took the form of an entry in the equity ledger of the company. For secured lending, the security was transferred from the account of the borrower to that of the lender. At maturity, the loan was either renewed or the lender was repaid, and shares were transferred back to the borrower. Contracts stipulated an interest rate, the loan amount, and the collateral. Haircuts are the share of the collateral not financed with the loan. Lending agreements were often rolled over, i.e., extended by additional (fixed) periods of six months. Our data refers to new contracts, not to renewals, which are generally unobservable.

Contracts specified critical price points which triggered margin calls. Suppose that a loan was backed by EIC stock with a face value of £1,000 and that the loan had an initial 20 percent haircut with the underlying stock trading at 200 percent.[11] A price decline below 190 percent triggered a margin call of £100 to restore the haircut, in this case to 21 percent. Subsequent price declines of 10 percentage points or more required additional margin.[12] If the borrower was unable to meet margin calls,

[11] In the eighteenth century, prices were quoted as percentage of face (or par) value.

[12] The initial haircut can be disaggregated into two components. The first element is the "distance to margin call," in this case the difference between 200 and 190 percent, or 0.05 of the value of the collateral. The second is "distance to loss," in this case 190 percent to 160 percent or 0.15 of the value of the collateral. If margin calls were honored, the "distance to loss" increased by 10 the moment the price fell below 190.

the lender had the right to liquidate the borrower's position. Other creditors had no claim on the collateral. Lenders could recoup the loan value and interest only. Any surplus had to be remitted to the borrower. If proceeds failed to cover principal and interest, the borrower was personally liable for the remaining balance.

The eighteenth century market for collateralized lending was highly decentralized. Direct lending between borrowers and lenders dominated. Only around 5 percent of transactions featured financial intermediaries. There was considerable dispersion in the level of haircuts: the market did not clear at a single haircut. Online Appendix Figure B.1 shows that, even conditional on a borrower's identity and the year a transaction took place, there was considerable heterogeneity in haircuts. Repeat lending was not common (other than through, generally unobservable, renewals). Rather, the matching of borrowers and lenders took place through search. Lenders had to have funds available at the right time. Often, the lender had just received the repayment of an earlier loan. The lender Denis Adrien Roest provides a good example of this. Roest was a wealthy *rentier* who frequently offered margin loans. Online Appendix Figure B.2 shows how Roest extended loans over time. He typically lent again after receiving the repayment of older loans. Since loans ran for a multiple of 6 (or 12) months, Roest's new loans were either extended in May (November) or June (December).

Many lenders were rich patricians. Of all lenders, 45 percent lent once in the period 1770–1775; another 26 percent lent 2 or 3 times. Only 3 percent of lenders lent more than 10 times. Of the borrowers, 38 percent engaged in 1 transaction, and another 35 percent in 2 or 3. Only 10 percent borrowed 10 or more times. Over 80 percent of transactions involved lenders and borrowers who had never done business with each other.[13] Online Appendix Figure B.3 shows the network of lenders and borrowers. Collateral values determine the thickness of the lines. The Seppenwoldes borrowed from many financiers. There are few exclusive (or privileged) lending relationships; most borrowers have multiple lenders.

B. *The EIC in 1772*

EIC stock prices had been falling for some time (panel A of Figure 2) prior to the events of 1772. The company's problems originated in Bengal. In 1757 the British had defeated the local rulers, allowing the EIC to collect local taxes and raise dividends. The EIC stock price increased from about 170 percent to 270 percent. The company squeezed the local population hard, contributing to the infamous Bengali famine of 1769–1773, which killed millions while undermining the company's financial position.[14] Information about the worsened state of the company was kept secret. Company directors were unwilling to reduce dividends. Eventually, matters came to a head. During the summer of 1772, the EIC had trouble rolling

[13] In online Appendix B we test more formally if random matching of lenders and borrowers can adequately explain the nature of lending in our sample. Specifically we calculate the Herfindahl index of every lender's loan portfolio during the precrisis period. We find that loan portfolios were not more concentrated than one would expect based on the random matching of borrowers and lenders. In other words, lenders did not specialize in lending to specific individual borrowers.

[14] Nevertheless, the company increased its dividends in March 1771. The shortfall was financed through credit. Local company men in India borrowed heavily through short-term bills (drawn on the company in London) and at home the Bank of England granted the company substantial loans.

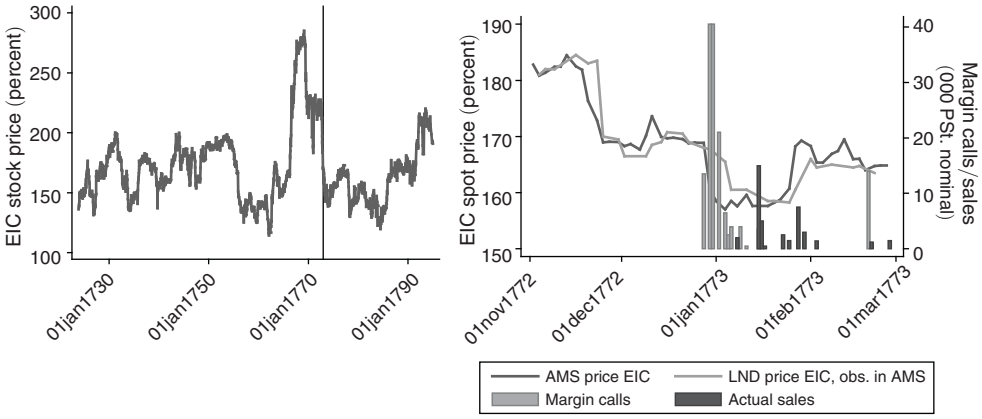

FIGURE 2. EIC STOCK PRICE IN AMSTERDAM BETWEEN 1723 AND 1793 AND EVENTS IN 1772/1773

Notes: In the left panel, the black vertical line indicates Christmas 1772. Right panel: East India Company (EIC) stock prices in Amsterdam (AMS) and London (LND); margin calls lenders to consortium; subsequent sell-off of collateral by lenders.

over its debt. In September 1772, it was forced to reduce dividends. Stock prices plummeted. After this, more bad news surfaced and stock prices kept falling. In the end the government intervened, placing the Company under more direct control through the Regulating Act of 1773 (Sutherland 1952). EIC stock prices stayed at depressed levels.

C. *The Seppenwolde Bankruptcy and Events after Christmas 1772*

In 1771, a group of Dutch financiers led by the Van Seppenwolde brothers took a large position in EIC stock. The EIC's price had fallen from 270 percent in 1768 to about 220 percent. The consortium speculated on a rebound in stock prices. It borrowed in Amsterdam to finance its position (totaling almost 6 percent of all outstanding stock).[15] Table 1 gives an overview of the participants of the consortium and their holdings around Christmas 1772. Two bankers provided a large share of the equity: Clifford and Sons and Abraham ter Borch and Sons. The falling EIC price devastated the consortium's position in 1772. When, in the second half of 1772, the EIC stock price fell below 200 percent, 190 percent and 180 percent, the consortium managed to meet margin calls.[16] However, when the EIC stock price fell below 170 percent after Christmas 1772, the consortium's funds were depleted. No further margin calls could be honored. All firms involved, including the two banks, "broke" and went bankrupt.

[15] Other investors went short in 1772, including the English speculator Alexander Fordyce, who was forced to close his positions just weeks before prices began to fall. Kindleberger's survey (2005) linked the bankruptcy of the Seppenwolde syndicate with Fordyce and the fall of the Ayr bank, claiming that the crisis began the summer of 1772. Similarly, Neal (1990) argues that the crisis started in October. This is mistaken. It is only after Christmas 1772 that problems emerged for the Seppenwolde syndicate. The official bankruptcy date is December 27 (SAA, "Stukken betreffende;" Wilson 1941). There is no evidence that Fordyce was linked with the syndicate. Moreover, the downfall of Fordyce led to an increase in EIC prices in the short run, improving the syndicate's position.

[16] SAA, "Stukken betreffende;" SAA, Van den Brink, 10,593–10,613; NA, Staal van Piershil, 381, 386, 396; OSA 3710; GAR, 52, 56, 90. Compare also with Wilson (1941) and Sautijn Kluit (1865).

Table 1—Positions of the Seppenwolde Syndicate, Christmas 1772

Member of the syndicate	Position (face value)	
	EIC	BoE
Hermanus van Seppenwolde	£63,600	£49,500
Johannes van Seppenwolde	£69,600	£17,000
Clifford & Chevalier	£44,500	0
Pieter van Peene	£2,000	£4,000
Total	£179,700	£70,500
Total outstanding	£3,194,080	£10,780,000
(fraction owned by syndicate)	(0.056)	(0.007)
Avg. monthly turnover (1770–1772)	£196,967	N/A
(fraction owned by syndicate)	(0.912)	N/A

Notes: Positions calculated at the end of 1772. Average monthly turnover is based on the turnover in the capital books of the respective companies. Actual market turnover would have been higher if transactions were netted out before changes in the capital books were made.

From December 28 onward a string of margin calls were issued (Wilson 1941). Since these calls were not met, lenders had the right to sell the collateral immediately. The right panel of Figure 2 shows the timing of these transactions. Gray bars indicate the time of the margin calls; the black bars show actual transactions. Many sales were delayed; most transactions were completed by the end of January 1773. Around the time the margin calls were issued, the median surplus was around 10 percent. Under normal circumstances lenders would have had a comfortable margin to liquidate the collateral. However, since many transactions were delayed, and prices after Christmas 1772 kept falling, the surplus at liquidation was often lower—many lenders liquidated at a surplus of just 2 or 3 percent (see Figure 3).[17] Nevertheless, the surplus at liquidation was always positive. Although lenders got close, they *all* escaped without losses.

Why lenders waited for several weeks to liquidate the collateral is unclear. At best, lenders could hope for repayment of principal and interest. Under the terms of the contract, there was no upside for them. It is possible that liquidity on the Amsterdam exchange initially dried up. The right panel of Figure 2 provides some support for this interpretation; it shows that EIC prices in Amsterdam were significantly below those in London. Since there was normally a close relationship between the two prices, driven by arbitrage (Koudijs 2016), this suggests local selling pressure. However, most lenders could afford to sell at a discount of up to 10 percent without losing a penny. This implies that the market had come to a virtual standstill.[18]

[17] The surplus at the time of liquidation cannot be reconstructed for every loan. Corroborating evidence comes from Johannes van Seppenwolde's bankruptcy papers that list all of his assets and liabilities (SAA, Tex den Bondt aanvulling 1 en 2, 347). The overview is complete, including everything from real estate to unpaid attorney fees. Not a single collateralized lending transaction in English securities led to a claim on the bankrupt estate (instead they all ended up on the asset side). Losses due to collateralized loans were pari passu with other claims—this means that they cannot have been repaid before the bankruptcy papers were drawn up. For example, a number of collateralized loans that had plantation mortgages as collateral did end up as claims in Van Seppenwolde's bankruptcy papers.

[18] To avoid a general fire sale, the consortium often asked lenders, "in the light of the current circumstances," to hold on to the shares for the time being (SAA, Van Den Brink, 10,602). Since there was no direct upside from liquidating at a profit, this equilibrium might have been stable, as long as there were some reputation costs from deviating and the surplus remaining on the positions was sufficient.

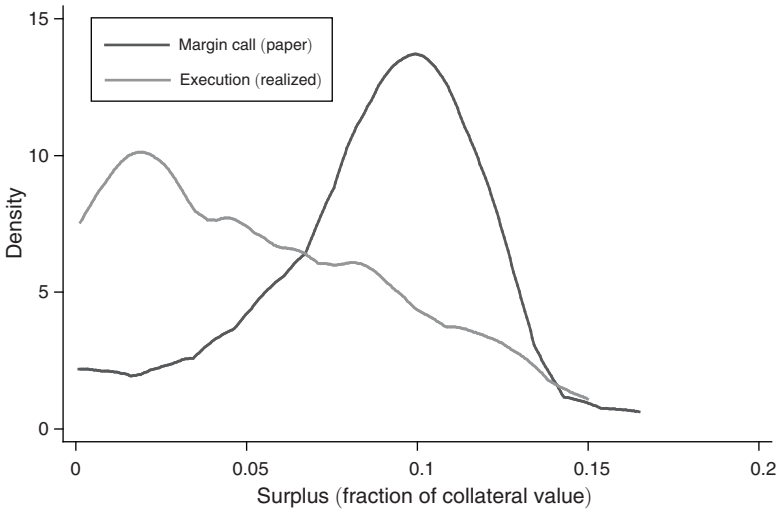

FIGURE 3. SURPLUS ON LOANS TO CONSORTIUM

Notes: Distributions of the surplus on secured loans (the difference between the value of the collateral and the loan), right after the issuing of margin calls on December 29 and after the actual execution of the underlying collateral.

Events were extensively covered in the press. On December 29, the periodical *De Koopman* reported a scarcity of buyers on the exchange. It mentioned that margin calls had been issued and that collateral would be sold. In addition, secured loans were difficult to obtain, "only on additional security" (*De Koopman*, p. 295). On January 3, the *Koopman* mentioned more margin calls and that more selling was imminent. It expressed the hope that "reality will become more fashionable now people are learning these specific lessons" (*De Koopman*, p. 310). After Christmas 1772, there was more turmoil on the Amsterdam exchange. The bankruptcy of old and renowned banks increased counterparty risk. Nonetheless, the Amsterdam market calmed down quickly. On January 14, 1773 the city of Amsterdam set up a discount facility where, on the security of domestic government bonds and nonperishable goods, anyone could borrow money. It was hardly used; of 2 to 3 million guilders available, only 335,000 were lent out. The official records mention that setting up the facility alone had restored the "general credit," and no more bankruptcies occurred.[19]

How unusual was the behavior of the EIC stock price in 1772? We measure returns as the log difference of prices over the standard six-month period: $r = \ln(p_t / p_{t-6})$. Online Appendix Table B.1 describes the data for three time periods—from the beginning of our sample in 1723 to the first half of 1772; the Seppenwolde episode; and the full sample from 1723 to 1794. On average, East India stock appreciated by 0.5 percent every six months during the half-century from 1723 to 1772. Returns during the Seppenwolde episode were dramatically lower, with prices declining by an average of 3.4 percent over six month periods between early 1770 and January 1773. The standard deviation was only slightly higher, but

[19] SAA, Beleenkamer, 1, 5; Sautijn Kluit (1865); Wilson (1941).

skewness was more negative. The maximum loss over a six-month horizon increased from 25.6 to 35.8 percent. Online Appendix Figure B.4 plots kernel densities. During the distress period the weight in the left tail dramatically increased. Prior to the second half of 1772, priced dipped by 20 percent or more in only 1.1 percent of all cases. Since average haircuts were 20 percent, this implies that in only 1 out of 100 lending events, the collateral values fell below the value of a loan. In the period January 1770 to January 1773, this frequency increased to over 7 percent.

II. Model

The previous section showed that lenders mostly offered funds to borrowers needing credit when one of the lenders' earlier loans expired. Only a few lenders and borrowers could do new business with each other at any one point in time. In this section, we model their interactions in a search-and-matching framework, following Geanakoplos (2003) and Simsek (2013). We analyze the case where borrowers' beliefs remain unchanged, but the beliefs of lenders diverge. More specifically, a fraction of lenders becomes more pessimistic than before. The aim is to analyze the impact on haircuts and interest rates. In addition, we establish conditions under which borrowers find it optimal to accept loans from more pessimistic lenders. Online Appendix G has the full solution to the model; here we sketch the main assumptions and results.

A. *Setup and Equilibrium*

Apart from a risk-free storage technology, there is a single risky asset. Following Geanakoplos (2003), the asset has a binominal payout.[20] There are three types of agents in the market $i \in \{1,2,3\}$ who are all competitive and risk-neutral but have different beliefs about the asset payout. Though they all agree that in the good state of the world the asset will pay $\overline{r}$, they disagree about the payoff in the bad state of the world: $\underline{r}_1 < \underline{r}_2 < \underline{r}_3$. Expected payouts are given by v_i. For simplicity, we assume that there are an equal number of type 1 and 2 agents in the market. The group of optimists is relatively small so that the equilibrium price never exceeds v_3. Throughout, we assume that there are shorting restrictions.[21]

We focus on the case where $v_2 < p < v_3$. In this scenario, type 3 agents would like to buy as much of the asset as possible, while agents 1 and 2 prefer to stay out of the market altogether. We assume that type 3 agents have wealth c_3. In addition, they can borrow from type 1 and 2 agents to increase their asset holdings. We model the market for these loans as a search market with matching frictions where borrowers try to find lenders. In their search, they cannot distinguish between type 1 and 2 lenders. When a borrower and lender meet, they Nash bargain over the surplus of the loan contract. The borrower has bargaining power $\theta \in [0,1]$.

[20] This can be seen as the continuous time limit to a distribution with full support (Cox, Ross, and Rubinstein 1979).

[21] Short selling in eighteenth century Amsterdam was possible but not accessible to all market participants, effectively creating short selling constraints (Koudijs 2015).

In this decentralized market, there will be two different sets of lending terms. A loan contract stipulates the size of the loan per unit of the asset l_j and the interest rate ρ_j for $j \in \{1,2\}$. Given c_3 and p this pins down q_j, the quantity of the asset a borrower can buy if matched with a lender of type j. The haircut, the fraction of the position in the asset that a borrower has to finance with his own capital c_3, is defined as

$$h_j = \frac{p - l_j}{p}. \tag{1}$$

We assume that a loan contract breaks down with some exogenous intensity; neither borrower nor lender can cancel the contract in the meantime. In online Appendix G we prove the following results:

PROPOSITION 1: *A loan contract will always be risk free from the perspective of the lender*, *i.e.*, $(1 + \rho_j) l_j = \underline{r}_j$.

In words, from the perspective of the lender, the payout in the bad state of the world will be sufficient to repay the loan, including interest. The intuition behind this result is similar to the one in Geanakoplos (2003). If the contract is risky, the lender expects to lose money in the bad state of the world. To compensate for this, he will charge a high interest rate in the good state of the world. In contrast, the borrower expects the lender's losses to be limited in the bad state of the world. He believes the lender will be able to recuperate a large fraction of the loan, if not everything. As a result, the risky interest rate is disproportionally high from the borrower's perspective. This makes risky borrowing unattractive. The optimal loan size will therefore not exceed the risk free amount. This implies that the interest rate ρ_j only captures surplus payments from borrower to lender and does not reflect risk compensation.

PROPOSITION 2: *As long as* $\underline{r}_1 < \underline{r}_2$, *we will have* $h_1 > h_2$.

All adjustment for risk happens through haircuts. Type 1 agents are more pessimistic about the bad state of the world and since contracts are risk free, this results is smaller loans and higher haircuts.

PROPOSITION 3: *As long as the valuations of type* 1 *and type* 2 *agents do not lie too far apart*, *specifically*

$$\underline{r}_2 < \frac{p}{a\underline{r}_1 + (1-a)p} \underline{r}_1, \tag{2}$$

with $a \in [0,1]$ *increasing in matching frictions, there will be a* full matching *equilibrium, that is, a borrower will always accept a loan contract from a type* 1 *lender.*

The type 2 lender is more optimistic and is willing to offer a bigger loan. There are two reasons a borrower accepts the type 1 loan and does not wait for a type 2 agent. First, there are matching frictions and it may take a while for a borrower to run into a type 2 lender who is not tied up in an existing loan contract. This carries

opportunity costs. Second, the type 2 lender will capture a part of the surplus generated by a type 2 loan through charging a higher interest rate. If the advantage from waiting for a type 2 lender is not too big, as captured by equation (2), a borrower will always accept a type 1 loan.

B. *Comparative Statics*

In the context of the Seppenwolde default, we interpret the model as follows. Initially, beliefs of type 1 and 2 lenders are identical—they both think that the return in the bad state of the world is $\underline{r}$. They only differ in the sense that type 1 lenders happen to lend to the Seppenwolde consortium. After the default, type 1 lenders update their beliefs such that $\underline{r}_1 < \underline{r}_2$, where, for simplicity, $\underline{r}_2$ is unchanged at $\underline{r}$. At the same time, due to a concurrent decline in asset prices, optimists lose capital. We model this as a reduction in c_3. To understand how this affects the equilibrium in the loan market, we derive the following comparative statics:[22]

LEMMA 1: *The difference in haircuts is decreasing in* $\underline{r}_1$, *that is*

$$\frac{\delta(h_1 - h_2)}{\delta \underline{r}_1} = \frac{\delta h_1}{\delta \underline{r}_1} - \frac{\delta h_2}{\delta \underline{r}_1} < 0. \tag{3}$$

Loan contracts are risk-free and when type 1 lenders become more pessimistic, h_1 will automatically go up such that $(1 + \rho_1) l_1 \leq \underline{r}_1$. At the same time, as type 1 lenders become more pessimistic, less funding becomes available for type 3 agents to purchase the asset and the equilibrium price falls. This leads to a decline in h_2 and the difference between type 1 and 2 haircuts will increase. In other words, after the Seppenwolde default, we expect haircuts on loans made by exposed lenders to go up compared to haircuts on loans made by unexposed lenders.

LEMMA 2: *The difference in haircuts is invariant to changes in* c_3, *that is*

$$\frac{\delta(h_1 - h_2)}{\delta c_3} = \frac{\delta h_1}{\delta c_3} - \frac{\delta h_2}{\delta c_3} = 0. \tag{4}$$

A drop in optimists' capital reduces the equilibrium price. Equation (1) indicates that both h_1 and h_2 will fall, leaving the difference between the two unchanged. This means that the Seppenwolde default itself has no differential effect on haircuts, except through changes in beliefs.

LEMMA 3: *The difference in interest rates can either be increasing or decreasing in* $\underline{r}_1$, *that is*

$$\frac{\delta(\rho_2 - \rho_1)}{\delta \underline{r}_1} = \frac{\delta \rho_2}{\delta \underline{r}_1} - \frac{\delta \rho_1}{\delta \underline{r}_1} \lessgtr 0. \tag{5}$$

[22] To get closed form solutions, we evaluate all comparative statics at the point where $\underline{r}_1 = \underline{r}_2 = \underline{r}$, tracing out what happens in response to a relatively small change in $\underline{r}_1$. In online Appendix G, we use numerical analysis to consider the impact of larger shocks. In general, results are consistent.

The impact on interest rates is ambiguous. A type 2 loan will become relatively more valuable to borrowers and, compared to a type 1 loan, will command a higher surplus payment (surplus effect). At the same time, the size of a type 2 loan will be relatively large (size effect). The interest rate ρ_2 is defined as the surplus payment divided by the loan size. Since both go up, the net effect is unclear and depends on the exact parameters of the model.

LEMMA 4: *The difference in semi-elasticities of type* 1 *and type* 2 *haircuts with respect to a change in* $\underline{r}_1$ *is larger* (*in absolute value*) *than the difference in semi-elasticities of type* 1 *and type* 2 *interest rates:*

$$\left|\frac{\delta h_1}{\delta \underline{r}_1} - \frac{\delta h_2}{\delta \underline{r}_1}\right| \frac{1}{h} > \left|\frac{\delta \rho_1}{\delta \underline{r}_1} - \frac{\delta \rho_2}{\delta \underline{r}_1}\right| \frac{1}{\rho}, \tag{6}$$

where h and ρ *are the initial haircut and interest rate corresponding to* $\underline{r}_1 = \underline{r}_2 = \underline{r}$.

The semi-elasticities indicate by what percentage haircuts or interest rates will increase (or decrease) given a unit change in $\underline{r}_1$. This lemma therefore states that, in relative terms, the differential impact of a change in $\underline{r}_1$ is larger for haircuts than for interest rates. The intuition is as follows. Since loan contracts remain risk free, a drop in $\underline{r}_1$ will have a first order impact on the loan size such that $(1 + \rho_1) l_1 = \underline{r}_1$. The adjustment in interest rates is smaller as the size and surplus effects largely cancel each other out.

III. Data

The starting point for our data is the (incomplete) index to the Amsterdam notary records compiled by Hart (SAA 30452) with entries for English stocks. We use information from all notaries listed in the registry dealing with collateralized loans for the years 1770 to 1775.[23] This yields a total of 424 loan transactions with English securities as collateral.[24] We also collect information on margin calls (insinuaties), and accounts of settlement dealing with the liquidation of collateral.[25] To calculate the haircut, we take the most recent price of the corresponding collateral in the Amsterdam market (available in the *Amsterdamsche Courant*). Table 2 provides an overview. The average loan value was 29,000 guilders, and the average collateral value was 36,000 guilders. For comparison, a skilled laborer could earn 1.40 guilders per day at the time, while prime Amsterdam real estate (on the famous *Heerengracht*) cost around 10,000 guilders (De Vries and Van der Woude 1997, graph 12.1; Bisschop 1968).

[23] We found the majority of loan contracts in the archives of notary Daniel van den Brink. Wilson (1941) was the first scholar to use these records.

[24] For the period 1770–1775, there are very few notarized loans collateralized with other securities. We did not find a single loan on Dutch East (VOC) or West India (WIC) stock. There are occasional loans on securitized mortgages to West-Indian planters or sovereign bonds issued by Austria-Hungary. These observations are infrequent and there are no secondary market prices available to calculate haircuts.

[25] Of these 424 transactions we omit six loans from our econometric analysis. Four loans were collateralized by rare, infrequently traded British government securities for which no prices are available. For two post-1772 loan transactions, lenders rolled over existing margin loans at artificially low haircuts instead of liquidating the collateral. These two observations belong neither to the treatment or control groups.

Table 2—Descriptive Statistics: Loan Contracts

Variable	Observations	Mean	SD	Min	Max
Real value of collateral (guilders)	418	36,271	27,734	4,782	238,058
Face value of collateral (£)	420	1,910	1,608	300	15,000
Loan value (guilders)	422	28,969	23,244	2,200	210,000
Haircut (fraction)	418	0.205	0.059	0.080	0.550
Interest rate (percent)	420	3.63	0.30	2.50	4.00
Non-EIC (BoE, SSC, 3 percent annuities)	422	0.256	0.437	0	1

Panel A of Table 3 presents information on the lenders, distinguishing those with and without exposure to the consortium. Categories overlap and totals do not add up to 100 percent. Around one-half of the lenders were merchants. Another one-half were *rentiers*. One-third of the lenders were government officials or judges. Another one-third were noblemen. Around one-fifth were women. Finally, a few lenders were specialists, i.e., individuals or firms who both lent and borrowed in the securities market. Lenders exposed to the Seppenwolde consortium were broadly similar to the rest. They were slightly more likely to be active in commerce or in local government, although the differences are not statistically significant.

Panel B presents information on borrowers, by the exposure of their lenders. Exposed ones lent less to specialists and Jews, and slightly more to merchants. The differences are small and mostly insignificant. We also reconstruct two risk measures for the borrowers. No detailed individual records survive. Instead, we rely on data from the ledgers of the Amsterdam Bank of Exchange. In the eighteenth century all Amsterdam citizens involved in commercial transactions had a current account at this large exchange bank. The bank had a monopoly on the issuance of deposit money, with deposits largely backed by specie reserves (Van Dillen 1964). There were no bank notes and the only alternative form of currency was specie (managed by small cashiers, Dehing 2012). To reduce transaction costs, large payments were usually settled through transfers between accounts in the Bank of Exchange (Quinn and Roberds 2014). Most of the Bank's original, handwritten, ledgers still exist. They contain daily information about transfers between individual accounts. Based on this information we can reconstruct daily account balances and a borrower's gross transaction volume. This information is available for 57 out of a total of 75 borrowers in our sample.[26] In total, we hand collected information for about 55,000 bank transactions between 1769 and 1775.

We use the information from the Bank's ledgers to construct two time-varying variables. The first relates a borrower's collateralized debt position to his or her overall activity in the bank; $\log(debt_{i,t}/transactions_{i,t})$, where the first term measures the total margin debt contracted by a borrower at a specific point in time (reconstructed from our sample of loan contracts); $transactions_{i,t}$ measures the average daily transaction volume for each borrower during the past year.[27] This variable

[26] The borrowers for whom we lack data did not live in Amsterdam and did not qualify for an account (Van Dillen 1964). They participated through the intermediation of cashiers or other agents. For borrowers who did have an account not all data are available because a number of the original ledgers are missing.

[27] Due to missing half-yearly ledgers we cannot always calculate annual averages based on a full year of data. We include the data point if the average is based on at least 150 daily observations.

Table 3—Lender, Borrower, and Loan Characteristics: Exposed versus Non-Exposed

	Exposed		Non-exposed		*t*-Stat
	(1)	(2)	(3)	(4)	(5)
Panel A. Lenders					
Merchants (fraction total)	44	(0.537)	29	(0.433)	1.258
Patricians (fraction total)	32	(0.352)	22	(0.286)	0.909
Nobles (fraction total)	26	(0.283)	26	(0.317)	−0.493
Females (fraction total)	17	(0.185)	16	(0.195)	−0.173
Specialists (fraction total)	3	(0.033)	3	(0.037)	−0.143
Panel B. Borrowers					
Merchants (fraction total)	33	(0.917)	16	(0.842)	0.833
Jews (fraction total)	15	(0.417)	10	(0.526)	−0.767
Specialists (fraction total)	2	(0.078)	2	(0.105)	−0.344
$\log(debt_{i,t}/transactions_{i,t})$	3.923		3.643		0.543
$\log(balance_{i,t}/transactions_{i,t})$	1.563		1.780		−0.573
Panel C. Loans					
Haircuts (fraction)	0.198		0.199		−0.092
Lending volume (£ 000s)	1.890		2.064		−0.552
EIC (fraction)	0.843		0.555		5.244
Interest rate (percent)	3.763		3.526		7.773

Notes: Panel A: General characteristics of lenders who were exposed to the Seppenwolde consortium versus lenders who were not. Exposed lenders are those who were forced to liquidate collateral after the events of Christmas 1772. Merchant: active in commercial activities; patrician: member of government or the judiciary; specialist: lender who also borrows. Columns 1 and 3 report total number of lenders; columns 2 and 4 fractions of the total (non-)exposed population. Reported *t*-statistics for the difference in fractions. Panel B: general characteristics of borrowers who obtained loans from exposed or non-exposed lenders (including the Seppenwolde consortium). Merchant: active in commercial activities; $debt_{i,t}$: total collateralized debt position borrower i at time t; $transactions_{i,t}$ and $balance_{i,t}$: borrower i's average daily transactions and balance in the Amsterdam Bank of Exchange during the preceding year. Panel C: general characteristics of the loans extended by exposed and non-exposed. Lending volume: measured by the face value of the collateral; EIC: fraction of loans collateralized with EIC stock. Data refer to 1770–1772 only. Reported *t*-statistics for the difference in mean between the two different subsamples. The *t*-statistics in panel C are based on standard errors clustered at the lender level.

can be seen as a (noisy) proxy for time-varying leverage. The intuition is that $transactions_{i,t}$ captures a borrower's total economic activity. If margin debt is small relative to the total volume of inflows and outflows, we consider a borrower safer: he will be less likely to default in case of adverse asset price movements. The second variable measures the relative cash position of a borrower: $\log(balance_{i,t}/transactions_{i,t})$, where the first term is the average daily balance of the past year. This captures what fraction of transaction volume is financed through a borrower's own account balance. The idea is that borrowers with strong cash positions are better able to respond to margin calls. Earlier research (on the crisis of 1763) indicates that this variable is a good predictor of financial intermediary distress in Amsterdam (Schnabel and Shin 2004; Quinn and Roberds 2015). We can reconstruct these two variables for about 75 percent of all loan contract observations. Panel B of Table 3 shows that, before Christmas 1772, exposed lenders lent to borrowers who were riskier in both dimensions, although differences are not statistically significant. Online Appendix Figure B.5 plots these two risk measures for the consortium: their debt (cash) positions were always above (below) the sample mean. We show in online Appendix Table B.2 that the two variables have significant explanatory power for haircuts in our overall sample, and pre-1773. We control for them in the main analysis.

Panel C of Table 3 summarizes loan characteristics before Christmas 1772. Haircuts are virtually indistinguishable for exposed and unexposed lenders. The average loan size per transaction was nearly identical for exposed and unexposed lenders. Exposed lenders charged 23 basis points (BPS) higher interest rates and were more likely to lend against EIC collateral. For both, the difference is highly statistically significant. In the empirical analysis, we take these differences explicitly into account. Table 4 analyzes loan transactions over time. Most of the loan contracts were signed before Christmas 1772. Lending to the consortium dominated, with 232 out of 362 loans taken out by the Seppenwolde group. After the crisis there was a strong reduction in the number of loan contracts, affecting both exposed and unexposed lenders. There is a significant exit of both lenders and borrowers, where non-exposed lenders are somewhat more likely to exit the sample, the implications of which we discuss below. After Christmas 1772 there are 28 lenders in the sample, including one new entrant. A large number of borrowers disappear from the sample, but there is also significant new entry. After 1772 there are a total of 32 borrowers, one-half of which are new entrants. Affected and nonaffected lenders extend the same share of loans to new borrowers. Finally, EIC stock dominates as collateral, but Bank of England (BoE) stock is also important. The consortium mainly borrowed to fund its EIC position; unsurprisingly, exposed lenders mainly lent on EIC as well (about 84 percent). Non-exposed lenders also lent on EIC but their share in BoE stock was higher (about 28 percent). After Christmas 1772 both groups of lenders converged and mainly lent on EIC. Both for lenders and borrowers, we use family fixed effects. In most cases, such as for fathers and sons, families are the relevant unit of observation.[28]

IV. Main Results

In this section, we analyze the change in haircuts after 1772 and its causes. In addition, we explore other margins of adjustment, including interest rates. We show that lending behavior of exposed and unexposed lenders prior to the distress event was identical, and that only investors who were faced with possible losses changed their behavior.[29]

A. *Haircuts*

Former Seppenwolde creditors tightened their lending criteria after Christmas 1772, while other lenders continued as before. We calculate average haircuts for exposed and unexposed lenders, before and after Christmas 1772 (Table 5). Exposed and unexposed lent at virtually the same rate before Christmas 1772; thereafter, the difference rose to 7 percentage points. Exposed lenders raised their haircuts from 20.7 to 26.1 percent; unexposed ones lowered theirs from 21.1 to 19.3 percent. The difference-in-differences is 7.3 percentage points, equivalent to approximately a one-third rise relative to the precrisis haircuts.

[28] In other cases, family members were often involved in similar transactions with the same counterparties. When dealing with partnerships, we treat the individual partners and the partnership itself as one fixed effect. We often cannot distinguish between transactions that are done in a person's own name or in name of the partnership.

[29] Exposed lenders are defined as lenders who sold collateral on the market.

Table 4—Number of Loans, Lenders, and Borrowers, and Collateral before/after Christmas 1772

Panel A. Number of loan contracts by period	From exposed: Yes	From exposed: No	Loans consortium: Yes	Loans consortium: No
Before Christmas 1772	217	145	232	130
After Christmas 1772	41	15		56

Panel B. Number of lenders and borrowers by period	Number of lenders: exposed: Yes	Number of lenders: exposed: No	Number of borrowers: from exposed: Yes	Number of borrowers: from exposed: No
Before Christmas 1772	92	82	34	38
After Christmas 1772	18	10	21	11
Number of new lenders/borrowers after Christmas 1772		1	12	4
Fraction of loans from/to new lenders/borrowers		0.11	0.44	0.40

Panel C. Types of collateral used by period (*fractions*)	EIC lenders exposed: Yes	EIC lenders exposed: No	BoE lenders exposed: Yes	BoE lenders exposed: No	Other lenders exposed: Yes	Other lenders exposed: No
Before Christmas 1772	0.84	0.55	0.14	0.38	0.01	0.06
After Christmas 1772	0.84	0.88	0.00	0.06	0.16	0.06

Notes: Sample characteristics before and after Christmas 1772. Panel A presents the number of new loans extended by type of lender and by whether loans were taken up by the Seppenwolde consortium. Exposed lenders are those who liquidated collateral after the default. Some loans taken up by the consortium were repaid before Christmas 1772. This explains why the total number of consortium loans is larger than the number of loans extended by exposed lenders. Panel B lists the number of lenders and borrowers. We separately report the number of lenders who were exposed (yes or no). Borrowers are differentiated by whether they borrowed from exposed lenders. The panel also lists the number of new lenders and borrowers that entered the market after Christmas 1772. New borrowers are differentiated by whether they borrow from exposed lenders. We also calculate the fraction of total lending extended by new lenders/taken up by new borrowers, e.g. 44 percent of all loans extended by exposed lenders after 1772 went to new borrowers. Total lending is measured in face value of the collateral. Panel C presents the type of collateral that was used in the loan transactions, again differentiated by whether lenders were exposed (yes or no). EIC is East India Company, BoE is Bank of England, Other includes South Sea Company (SSC) and government securities.

In online Appendix Figure B.6 we plot distributions of haircuts for exposed and unexposed lenders, before and after the crisis episode. The left panel refers to unaffected lenders, before and after Christmas 1772. The modal haircut for both periods is 20 percent; the somewhat thicker tails mainly reflect smaller sample size. The Kolmogorov-Smirnov test for the difference in distributions is insignificant with a p-value of 0.155. In the right panel, we plot the distributions for those affected by the Seppenwolde episode. Here, a distinct shift to the right is visible, statistically significant with a p-value of less than 0.001, with the mode rising from 20 percent to 25 percent. After December 1772, many lenders insisted on 30 percent or more; previously, few had lent at a rate above 30 percent.

In panel A of Table 6, we analyze the effect of almost losing money in the Seppenwolde transactions on haircuts econometrically. We estimate the following equation:

$$(7) \qquad Haircut_{i,t,} = \beta_1 Exposed_i + \beta_2 Exposed_i \times Post\,1772_t + \beta_3 nonEIC + \varepsilon_{i,t} + \zeta_{i,t},$$

Table 5—Simple Difference-in-Differences Estimate Haircuts (*EIC Stock Only*)

	Before Christmas 1772	After Christmas 1772	Δ
Non-exposed	0.211	0.193	−0.018
Exposed	0.207	0.261	0.054
Δ	−0.004	0.069	*0.072*

Notes: Average haircuts on EIC stock, by exposed and non-exposed lenders, before and after Christmas 1772. Haircuts calculated as the fraction of the collateral value not financed with a loan. Exposed lenders: those who were forced to liquidate collateral after Christmas 1772. Each observation is a new contract. Averages are weighted by the face value of collateral. The difference-in-differences estimate is in italics in the lower-right corner.

where $\varepsilon_{i,t}$ includes year dummies. In some specifications, we use lender and borrower characteristics or fixed effects. $\zeta_{i,t}$ is the error term. We pool observations from all types of collateral, and control for asset type separately in our regressions. In column 1, we report pooled ordinary least squares (OLS) results with clustered standard errors clustered at the lender level. Exposed financiers lent with lower haircuts on average, but the difference is small and insignificant. Collateral other than the EIC was also associated with markedly lower haircuts. The variable of main interest is the interaction of being exposed with the *Post 1772* dummy (coefficient β_2)—the average change in haircuts after the default of the Seppenwolde syndicate for lenders who almost lost money. The estimated shift for exposed lenders after 1772 is 7.6 percentage points, significant at the 1 percent level. Relative to the precrisis average of 21.9 percent, this is a dramatic change. In column 2, we add borrower and lender type dummies to account for the changing composition of the sample. The estimated coefficient is now 6.6 percentage points, somewhat smaller than before, and also highly significant. In columns 3 to 5 we include lender and borrower family/firm fixed effects. The panel is unbalanced and these fixed effects should control for possible changes in the composition of lenders and/or borrowers in the sample. In addition they capture unobservables at the lender/borrower level.[30]

One concern might be that the composition of lenders changed after Christmas 1772. Suppose that lenders that specialized in riskier lending had a higher likelihood of staying in the sample. Also suppose that these lenders were more likely to extend credit to the Seppenwolde consortium pre-1773. Such a particular change in the composition of lenders could drive our results. In column 3, we use lender family fixed effects and borrower type dummies to explicitly test for this. The coefficient on the interaction term is stable at 6.1 percentage points and significant at the 10 percent level. This implies that the possible change in the composition of lenders is not responsible for our results.

Did affected lenders specialize in more risky lending after Christmas 1772, perhaps because they acquired particular knowledge during the Seppenwolde bankruptcy? In column 4, we use borrower family/firm fixed effects and lender type dummies. The coefficient on the interaction term falls to 4.0 percentage points, but is still significant at the 10 percent level. This suggests that the possible self-selection of exposed

[30] Table 6 reports the number of observations had we run a balanced panel. The inclusion of fixed effects implies a significant loss of observations. The fixed effect estimates should therefore be interpreted as robustness checks rather than benchmark estimates.

TABLE 6—BENCHMARK ESTIMATES

	OLS (1)	OLS (2)	FE (3)	FE (4)	FE (5)
Panel A. Haircuts					
Exposed	−0.005	−0.003		−0.000	
	(0.005)	(0.005)		(0.006)	
Exposed × Post 1772	0.076	0.066	0.061	0.040	0.064
	(0.022)	(0.023)	(0.035)	(0.024)	(0.036)
Non-EIC	−0.059	−0.056	−0.049	−0.052	−0.047
	(0.006)	(0.006)	(0.011)	(0.008)	(0.015)
Constant	0.219	0.245	0.244	0.211	0.190
	(0.006)	(0.017)	(0.025)	(0.012)	(0.037)
R^2	0.334	0.440	0.630	0.659	0.798
Panel B. Interest rates					
Exposed	0.072	0.048		0.074	
	(0.036)	(0.034)		(0.041)	
Exposed × Post 1772	−0.049	−0.034	−0.080	0.035	0.066
	(0.099)	(0.099)	(0.132)	(0.113)	(0.217)
Non-EIC	−0.078	−0.093	−0.085	−0.104	−0.078
	(0.036)	(0.034)	(0.050)	(0.049)	(0.053)
Constant	3.527	3.637	3.674	3.559	3.792
	(0.036)	(0.096)	(0.101)	(0.071)	(0.171)
R^2	0.511	0.564	0.741	0.699	0.832
Year dummies	Yes	Yes	Yes	Yes	Yes
Lender type dummies	No	Yes		Yes	
Borrower type dummies	No	Yes	Yes		
Lender FE	No	No	Yes	No	Yes
Borrower FE	No	No	No	Yes	Yes
Observations	418	387	418	387	418
Observations (if balanced)			166	77	33
Number of lenders	177	152	177	152	177
Number of borrowers	72	70	72	70	72

Notes: Regression estimates for all English securities. Observations refer to new contracts and are weighted by the face value of the collateral. Haircuts are calculated as the fraction of the collateral value that is not financed with a loan. Interest rates are annual. Exposed lenders are those who were forced to liquidate collateral after the events of Christmas 1772. Lender and borrower type dummies are as in Table 3. The interaction between the *Exposed* and the *Post 1772* dummies captures the difference-in-differences effect. Lender and borrower fixed effects refer to fixed effects on the family/firm level. Robust standard errors (clustered at the lender level) are reported in parentheses.

lenders into riskier borrowers cannot account for our results, to the extent that these risks are time-invariant. In Section VB, we explore this further. In the final column, we include both borrower and lender family/firm fixed effects, to capture changes in lending rates that come from compositional change in the pool of both debtors and creditors. The interaction coefficient is somewhat larger at 6.3 percentage points. We also examine the potential role of differential precrisis trends. Online Appendix Figure 1.A plots trends over time for exposed and unexposed lenders. There is no difference before Christmas 1772; it is only thereafter that haircuts diverge substantially.

B. *Interest Rates*

Next, we examine interest rates. In panel B of Table 6, we estimate the same specifications as before, using interest rates as the dependent variable. The model

in Section II predicts that the differential increase in perceived risk should mainly affect collateral requirements. Interest rates only reflect surplus payments and, according to the model, should be less affected than haircuts. Panel B shows that there is no significant differential change in interest rates after 1772. In the estimates of columns 1–3 it is slightly negative, implying that exposed lenders charged lower interest rates after Christmas 1772. However, the coefficient is always economically small and never significant. After introducing borrower fixed effects, the coefficient turns positive, but is still small and insignificant. Overall, these results indicate that interest rates were not used by exposed lenders to adjust for increases in perceived risk.[31]

Online Appendix Figure B.7 shows the development of interest rates over time. Interest rates charged by exposed and non-exposed lenders track each other very closely, both before and after Christmas 1772. The figure indicates a shift to lower interest rates after Christmas 1772 that occurs for both groups of lenders.

C. *Other Margins of Adjustment*

Apart from haircuts and interest rates, we also examine other changes in lender behavior. First we consider the decision to continue lending. Overall exit rates were quite high (Table 4). Surprisingly, affected lenders were more likely to stay in the sample than unaffected ones.[32] Online Appendix Table B.3 indicates that the difference in attrition between exposed and non-exposed is not statistically significant though. Among exposed lenders, those most heavily exposed to the consortium were less likely to stay in the sample, even if we control for total lending activity. Conditional on staying in the market, exposed lenders did reduce their overall exposure to collateralized loans. In Table B.4 we analyze both total lending (columns 1–3) and lending excluding loans made to the Seppenwolde consortium (all before Christmas 1772) (columns 4–6). On average, those who were exposed lent more than the rest before the crisis (38,655 versus 36,917 guilders). Afterward, the exposed lenders who stayed in the market lent less (24,248 versus 28,286 guilders)—a decline of 37 percent (versus 24 percent for non-exposed lenders).

Next, we examine whether exposed lenders shifted toward less risky loans. Table 4 shows that after the Seppenwolde event, exposed lenders did not reduce the fraction of loans extended against EIC stock, the riskiest security. At the same time, non-exposed lenders became more likely to lend on EIC and the difference between exposed and non-exposed disappeared. There is evidence, however, that exposed lenders started to lend to safer borrowers. Panel A of Table 7 shows that riskier borrowers were more likely to exit the sample after Christmas 1772; panel B suggests that this is, at least in part, driven by the exposed lenders. Before the default of the consortium, they lent to borrowers with debt levels that were

[31] The summary statistics in Table 4 indicated that exposed lenders tended to charge 23 additional BPS to borrowers before the Seppenwolde default. In column 1 of Table 6, panel B, this drops to about 7 BPS. This reduction is the result of the introduction of year fixed effects; exposed lenders happened to extend loans in periods with relatively high interest rates. When we control for lender and borrower type dummies the coefficient falls to about 5 BPS and becomes statistically insignificant.

[32] One possibility, for which we only have anecdotal evidence, is that exposed lenders financed the positions of new buyers to shed EIC stock they now held.

about 8 percent higher in log terms; afterward, borrowers' debt levels were 8 percent lower on average. Log cash balances were 15 percent lower before the crisis, but about 5 percent higher afterward. This suggests that they preferred to match with less risky borrowers. To sum up, there is ample evidence that haircuts were not the only dimension of differential adjustment for exposed lenders, but the most important one overall.

D. *Duration of Effects*

How long does it take for beliefs of exposed and non-exposed lenders to converge? In online Appendix Table B.5, we add time elapsed since the crisis to our regression. We run the following specification:

$$(8)\quad Haircut_{i,t} = \beta_1 Exposed_i + \beta_2 Exposed_i \times Post1772_i + \beta_3 TimeSinceEvent + \beta_4 Exposed_i \times TimeSinceEvent + \beta_5 nonEIC + \varepsilon_{i,t} + \zeta_{i,t},$$

where *TimeSinceEvent* is equal to zero before Christmas 1772 and equal to the time elapsed thereafter (in years). The interaction between the *Post 1772* and *Exposed* dummies captures the instantaneous differential impact on haircuts (β_2). The interaction between the *Exposed* dummy and *TimeSinceEvent* measures the degree to which haircuts converge afterward (β_4). To calculate the differential impact after six months, we can subtract $0.5 \times \beta_4$ from β_2. The estimates imply that within two years, the treatment's impact has largely dissipated. However, since the number of observations falls over time, the decline in haircuts is not tightly estimated and not significant at standard confidence levels.

V. Alternative Explanations

In this section we perform a number of robustness exercises. We first show that exposure to the East India Company is not responsible for the change in lending terms. In addition, we demonstrate that time varying borrower characteristics and underlying lender heterogeneity cannot explain the patterns in the data. We also show that network effects do not drive our results. Finally, we show that results are not driven by the immediate aftermath of the Seppenwolde bankruptcy, and that the significance of our findings is robust to alternative estimation techniques.

A. *Specialization in Risky Lending*

The EIC's stock price decline after September 1772 is the fundamental cause of the crisis episode we examine. Table 4 shows that individuals lending to the consortium were highly exposed to the EIC, suggesting that they specialized in (ex post) riskier lending, as demonstrated by the higher interest rates they charged. It is possible that the events of Christmas 1772 served as a general wake-up call that collateralized lending was riskier than initially expected. The change in haircuts would then reflect a simple risk-based adjustment, without any need for personal experience changing

TABLE 7—BORROWER ATTRITION AND RISKINESS

Panel A. Attrition of borrowers after Christmas 1772 (logit, 1 = exit)	Including consortium (1)	Excluding consortium (2)
$\log(debt_{i,t}/transactions_{i,t})$	0.048	0.055
	(0.043)	(0.061)
$\log(balance_{it}/transactions_{it})$	−0.094	−0.104
	(0.056)	(0.092)
Observations	41	39
Pseudo-R^2	0.063	0.043

Panel B. Riskiness borrowers before/after Christmas 1772: exposed versus non-exposed	$\log(debt_{i,t}/transactions_{i,t})$			$\log(balance_{i,t}/transactions_{i,t})$		
	(1)	(2)	(3)	(4)	(5)	(6)
Exposed	0.452		0.545	−0.172		−0.311
	(0.222)		(0.221)	(0.139)		(0.115)
Post 1772		0.327	0.905		1.360	1.114
		(0.384)	(0.448)		(0.184)	(0.514)
Exposed × Post 1772			−0.926			0.410
			(0.680)			(0.532)
Constant	3.972	4.193	3.882	0.930	0.642	0.819
	(0.163)	(0.112)	(0.166)	(0.112)	(0.055)	(0.097)
Observations	342	342	342	342	342	342
Adjusted R^2	0.015	0.002	0.021	0.004	0.212	0.228

Notes: Panel A: logit estimates investigating whether a borrower drops out of the sample after Christmas 1772. $debt_{i,t}$: total margin loan position borrower i at time t. $balance_{i,t}$ ($transactions_{i,t}$): average daily balance (transaction volume) of borrower i in the Amsterdam Bank of Exchange during the 52 weeks prior to time i. The table reports marginal effects, e.g., an increase in balance over transactions by 1 log point makes it 9.4 percent less likely that a borrower drops out of the sample. Panel B: OLS estimations at the loan level, investigating whether exposed and non-exposed lenders lent to different types of borrowers after Christmas 1772. Robust standard errors (clustered at the lender level) are reported in parentheses.

risk attitudes.[33] To deal with this concern, we show that distinguishing between lenders with a high vs. low (precrisis) specialization in EIC stock, or charging high vs. low interest rates, does not affect our results. This is true in a standard regression setting; it also emerges clearly when we match lenders based on their precrisis usage of EIC collateral and interest rates.

In panel A of Table 8, we first compare results for lenders with high vs. low exposure to EIC collateral before 1773. Those with high exposure raise haircuts by 4.8 percent; those with low exposure, by 6.7 percent. The difference is not significant. We do the same for interest rates: those who charged low interest rates before increased haircuts by 3.7 percent. Those who charged higher interest rates raised haircuts by 9.3 percent. Again, this difference is not statistically significant. Furthermore, when we add interactions between interest rates and EIC exposure and the *Post 1772* dummy in the full sample estimates, *Exposed × Post 1772* remains economically and statistically significant at either the 1 or 10 percent level.[34] There

[33] Note that the fact that lenders exposed to the Seppenwolde consortium charged higher haircuts is in line with this alternative interpretation. We thank an anonymous referee for pushing our thinking on this point.

[34] When we include interactions between the *Post 1772* dummy and the interest rate and EIC share measure at the same time, the interaction with the *Exposed* dummy has a coefficient of 0.078, statistically significant at the 5 percent level.

Table 8—Lenders' Risk Preferences

	EIC share			Interest		
	$<p(50)$ (1)	$\geq p(50)$ (2)	(3)	$<p(50)$ (4)	$\geq p(50)$ (5)	(6)
Panel A. OLS Estimates: sample splits and interactions						
Exposed	−0.003	−0.005	−0.005	−0.009	−0.009	−0.005
	(0.006)	(0.008)	(0.006)	(0.006)	(0.012)	(0.005)
Exposed × *Post 1772*	0.048	0.067	0.056	0.037	0.093	0.086
	(0.055)	(0.033)	(0.033)	(0.032)	(0.035)	(0.027)
χ^2 stat.		0.02			1.52	
(p-value)		(0.886)			(0.217)	
Non-EIC	−0.052	−0.014	−0.055	−0.060	−0.053	−0.057
	(0.009)	(0.006)	(0.010)	(0.008)	(0.012)	(0.006)
Non-EIC × *Post 1772*	0.040	−0.021	0.019	0.023	0.024	0.021
	(0.048)	(0.025)	(0.021)	(0.030)	(0.025)	(0.018)
EIC share/interest			0.005			0.009
			(0.013)			(0.015)
EIC share/interest × *Post 1772*			0.041			−0.134
			(0.059)			(0.061)
Objectives	188	199	384	189	198	381
Adjusted R^2	0.383	0.259	0.417	0.481	0.349	0.428
Panel B. Nearest neighbor matching estimator						
ATT	0.068	0.055	0.078	0.072	0.062	0.063
	(0.022)	(0.022)	(0.020)	(0.026)	(0.014)	(0.012)
Additional matching variables						
Continuous	x	EIC share	x	Interest	x	x
Exact	x	x	Decile EIC share	x	Decile Interest	Deciles both
Observations	418	415	415	412	412	412

Notes: Dependent variable: haircuts. Panel A: regression estimates for all English securities, weighted by the face value of the collateral. All specifications include year fixed effects and lender and borrower type dummies. The interaction between *Non-EIC* and the *Post 1772* dummy captures any changes in haircuts on collateral other than the EIC. EIC share is the proportion of a lender's loan portfolio before 1773 that is collateralized with EIC stock. Interest is the average interest rate charged by a lender before 1773. Sample splits above and below the median investigate what part of the distribution the effect is coming from. We report a χ^2 test on whether the interaction effect is statistically different. The interaction term with the *Post 1772* dummy captures whether lenders who seem to specialize in risky lending (more EIC as collateral, higher interest rates) adjust haircuts differently after Christmas 1772. Robust standard errors (clustered at the lender level) are reported in parentheses. Panel B: Nearest neighbor matching estimates using the face value of the collateral as weights, presenting the average effect for the treated. Matching variables always included: *Exposed*, *Post 1772*, *non-EIC*, and year dummies. Robust standard errors presented in parentheses.

is some evidence that lenders specializing in EIC lending increased haircuts, but this does not drive the differential response of the exposed. Throughout, the table includes the interaction of collateral type and the *Post 1772* dummy. The coefficient on this term indicates that haircuts on EIC did not increase after Christmas 1772.

An alternative approach is to use nearest neighbor matching to estimate treatment effects on the treated. Panel B first shows the basic matching result for *Exposed* × *Post 1772*, where we derive propensity scores from the *Exposed*, *Post 1772*, *Non-EIC*, and year dummies. Column 2 adds the share of EIC-based lending, pre-1773, as a matching variable. In column 3, we use exact matching, restricting the estimator to only use comparisons with contracts by lenders who are in the

same decile of pre-1773 EIC exposure. Columns 4 and 5 apply the same logic using pre-1773 interest rates. Finally, the estimates in column 6 rely on direct comparisons between lenders who are in same interest rate and EIC exposure deciles. In all cases, the results are highly significant and larger than 5 percent, indicating a large upward shift in haircuts among closely matched lenders depending on whether they had lent to the Seppenwoldes. This strongly suggests that a simple reaction to risk is not responsible for the results that we find.[35]

B. *Time-Varying Borrower Characteristics*

Including borrower fixed effects in our specification drives down the differential increase in haircuts after 1772 (Table 6, panel A, column 4), suggesting that borrower characteristics matter. In this subsection we control explicitly for time varying borrower risk measures. Exposed lenders tended to match with riskier borrowers with larger debt positions and lower bank balances (Table 4).[36] If, after the Seppenwolde default, lenders generally put more emphasis on risk measures like debt and cash positions, this would increase haircuts charged by exposed lenders automatically.[37] We therefore investigate whether risk-related borrower characteristics became more important over time in determining haircuts. We use the two proxy measures derived from the borrowers' bank account balances: $\log(debt_{i,t}/transactions_{i,t})$ and $\log(balance_{i,t}/transactions_{i,t})$, the amount of collateralized debt and a borrower's cash position relative to its total commercial and financial activities. In addition, we use time-borrower fixed effects, exploiting the (relatively limited) number of borrowers who borrowed from both exposed and unexposed lenders after 1772.

Column 1 of Table 9 adds the two time-varying risk measures to the specification from column 4 in Table 6, panel A. Coefficients have the expected sign and are highly statistically significant. An increase in margin debt from the twenty-fifth to the seventy-fifth percentile increases haircuts by 1.8 percentage points. A similar increase in a borrower's cash position reduces haircuts by 3.4 percentage points.[38] Importantly, the coefficient on our interaction term is unaffected. In column 2, we introduce interaction terms between the *Post 1772* dummy and the two risk measures. After 1772, lenders put more emphasis on cash levels; the coefficient almost doubles. At the same time, margin debt levels seem to have become irrelevant.[39] This reevaluation of risk slightly reduces the coefficient on *Exposed* $\times$ *Post 1772*, but it remains significant. As a further robustness check, we replicate these estimates including lender fixed effects in columns 3 and 4. Results are arguably stronger. In sum, borrower fixed effects and time varying borrower characteristics play an

[35] In online Appendix D, we examine a related possibility—that direct portfolio exposure to EIC price movements was responsible for the paring back of risks. We also find no evidence for that.

[36] Panel B of Table 7 documents that though exposed lenders initially dealt with riskier clients, they started to lend to safer borrowers after 1772, suggesting that an increased emphasis on borrower risk characteristics cannot explain the differential impact on haircuts. However, these changes are not statistically significant.

[37] We thank an anonymous referee for pointing this out.

[38] A fuller investigation of the impact of these two time-varying measures is in the online Appendix Table B.3.

[39] When we estimate separate regressions for the period before and after 1772, we obtain a coefficient on the debt/transactions variable of 0.11 (SE 0.041) pre-1772 and -0.014 (SE 0.05) post-1772. In online Appendix Figure B.8, we illustrate the marginal effects of higher debt levels pre- and post-1772.

Table 9—Haircuts and Time-Varying Borrower Riskiness

	(1)	(2)	(3)	(4)	(5)
Exposed	0.001	0.002			−0.000
	(0.006)	(0.006)			(0.006)
Exposed × *Post 1772*	0.052	0.045	0.101	0.077	0.054
	(0.021)	(0.019)	(0.027)	(0.023)	(0.024)
Non-EIC	−0.050	−0.051	−0.045	−0.047	−0.053
	(0.008)	(0.008)	(0.014)	(0.015)	(0.008)
$\log(debt_{i,t}/transactions_{i,t})$	0.010	0.010	0.014	0.015	
	(0.004)	(0.004)	(0.005)	(0.005)	
$\log(debt_{i,t}/transactions_{i,t}) \times$ *Post 1772*		−0.017		−0.023	
		(0.009)		(0.012)	
$\log(balance_{i,t}/transactions_{i,t})$	−0.023	−0.021	−0.027	−0.026	
	(0.007)	(0.011)	(0.009)	(0.015)	
$\log(balance_{i,t}/transactions_{i,t}) \times$ *Post 1772*		−0.017		−0.018	
		(0.008)		(0.013)	
Year dummies	Yes	Yes	Yes	Yes	Yes
Lender type dummies	Yes	Yes			Yes
Borrower FE	Yes	Yes	Yes	Yes	No
Lender FE	No	No	Yes	Yes	No
Borrower-time FE	No	No	No	No	Yes
Observations	317	317	341	341	381
Adjusted R^2	0.586	0.591	0.634	0.642	0.588

Notes: Dependent variable: haircuts. Regression estimates for all English securities. Observations refer to new contracts and are weighted by the face value of the collateral. Exposed lenders are forced to liquidate collateral after Christmas 1772. The interaction *Exposed* × *Post 1772* captures the difference-in-differences effect. $debt_{i,t}$: total margin loan position borrower i at time t. $balance_{i,t}$ ($transactions_{i,t}$): average daily balance (transaction volume) of borrower i in the Amsterdam Bank of Exchange during the 52 weeks prior to time i. Lender type dummies are as in Table 3. Borrower and lender FE refer to fixed effects on the family level. Robust standard errors (clustered at the lender level) in parentheses.

important role in determining haircuts, but accounting for them leaves the differential response of lenders to the Seppenwolde bankruptcy largely unchanged.

In column 5 we take the analysis one step further by including borrower-time fixed effects. This specification should fully control for changes in borrower characteristics. Effectively, we are identifying off those borrowers who borrowed from both exposed and non-exposed lenders after Christmas 1772. This is the most stringent test we can perform, but it limits the number of available data points. Only three borrowers were sufficiently active after Christmas 1772 to borrow from both exposed and non-exposed lenders. In total, there are 16 unique combinations between borrowers and lenders that involve 13 different lenders: 8 exposed and 5 non-exposed. These loan transactions constitute a quarter of all available observations after Christmas 1772 (details are in Table 10). The estimate of the interaction effect between the exposed and post-event dummies is statistically significant at the 1 percent level and the economic effect (5.4 percent) is similar to the benchmark estimates in Table 6, panel A.

C. *Destruction of Relationship Capital*

Can the need to find new business partners after Christmas 1772 explain the sudden increase in haircuts? If the Amsterdam market for collateralized loans was

Table 10—Details of Borrower-Time Fixed Effects

Non-exposed				Exposed			
Lender	Haircut	Face value coll.	Type	Lender	Haircut	Face value coll.	Type
Panel A. Borrower Nimweegen							
Boreel	0.17	2,000	P,4	Aalst	0.22	1,000	M,9
Rutgers	0.18	1,000	M,8	Graafland	0.17	1,000	P,7
			M,N,7				M,S,1
Straalman	0.18	2,500		Pereira	0.21	5,000	0
				Steenis	0.25	4,000	P,F,8
Wtd. avg.	0.18			Wtd. avg.	0.22		
						Diff.	0.04
Panel B. Borrower Guttierez							
			M,9				M,P,1
Poorten	0.15	2,000		Berewout	0.23	1,000	0
Rutgers	0.30	1,000	M,6	Boddens	0.31	1,000	M,8
Straalman	0.30	1,000	M,N,8	Bors	0.31	2,000	N,F,8
				Hagen	0.31	2,000	N/A,6
Wtd. avg.	0.23			Wtd. avg.	0.30		
						Diff.	0.07
Panel C. Borrower Tile							
Winter	0.26	1,000	M,7	Boddens	0.26	1,000	M,10
						Diff.	0.00
				Weighted difference			0.05

Notes: This table documents the individual transactions that drive the borrower-time fixed effects results. Information is restricted to the three borrowers who, after Christmas 1772, borrowed from both exposed and non-exposed lenders (Jan Louis van Nimweegen, Olivier Guttierez and Penha, and Reinier Christiaan Tile). The left-hand side of the table shows lending transactions with exposed lenders, the right-hand side presents transactions with non-exposed lenders. We aggregate information by borrower-lender pair. All averages are weighted by the total face value of the collateral underlying a set of transactions. All collateral refers to EIC stock. Lender type: P – patrician, M – merchant, N – noble, F – female, S – specialist. Numbers refer to the decile of total lending each lender belongs to, e.g., P, 7 means that a lender is a Patrician whose total lending is in the seventh decile of the distribution of total lending activity.

dominated by network lending, the Seppenwolde collapse could have depleted "intermediation capital" (Bernanke 1983). In that case, lenders needed to screen out new borrowers, using higher haircuts. We already argued that relationship lending was not central to the Amsterdam loan market. Here, we show that changes in haircuts over time for the exposed lenders cannot be explained by the destruction of "relationship capital." First, we examine if exposed lenders saw a greater decline in repeat business than unexposed ones (Table 11). The probability of being matched with a repeat borrower fell after Christmas 1772. As the consortium exited the market and new borrowers entered, repeat business declined. This was true for both exposed and non-exposed lenders. This implies that the relatively high haircuts charged by exposed lenders after Christmas 1772 cannot be the result of differentially greater destruction of relationship capital.

Second, we start from the assumption that lenders that are heavily invested in a particular client relationship will have more concentrated portfolios. We then estimate

$$(9)\qquad Haircut_{i,t,} = \beta_1 Exposed_i + \beta_2 Exposed_i \times Post\,1772_t + \beta_3 Herfin_i + \beta_4 Herfin_i \times Post\,1772_t + \beta_5 nonEIC + \varepsilon_{i,t} + \zeta_{i,t},$$

Table 11—Probability of Lender Matching with a Repeat Borrower

	OLS (1)	OLS (2)	Logit (3)	Logit (4)	Probit (5)	Probit (6)
Post 1772	−0.211	−0.196	−0.211	−0.209	−0.211	−0.207
	(0.050)	(0.108)	(0.050)	(0.110)	(0.050)	(0.104)
Exposed		0.026		0.020		0.021
		(0.109)		(0.086)		(0.091)
Exposed × *Post 1772*		−0.018		−0.002		−0.006
		(0.122)		(0.196)		(0.173)
Observations	224	224	224	224	224	224
Adj. R^2	0.046	0.037				

Notes: Dependent variable is a lender matched to a repeat borrower (one (s)he has lent to before) no = 0; yes = 1. Unit of observation: new loan contracts. To minimize measurement error of the repeat borrower variable, transactions after Jan 1, 1772 only. *Post 1772* is a dummy for contracts signed after Christmas 1772. *Exposed* is a dummy for lenders who were exposed to the Seppenwolde bankruptcy. We report marginal effects. Estimates should be interpreted as the change in the probability of being matched with a repeat borrower in response to a change in the dummy variables from 0 to 1. Robust standard errors (clustered at the lender level) in parentheses.

where $\varepsilon_{i,t}$ includes time effects as well as borrower and lender characteristics, $\zeta_{i,t}$ is a random error, and β_4 captures whether exposed lenders increased haircuts more if they engaged in more relationship lending precrisis (a higher Herfindahl index). Online Appendix Table C.1 shows that this is not the case; if anything, a higher degree of concentration before Christmas 1772 (more relationship lending) lead to lower haircuts. This effect is not statistically significant.

D. *Differences in Lenders' Underlying Characteristics*

Exposed lenders may have been differentially affected by the crisis. For example, if one type of lender had more exposure to the Seppenwolde brothers—say, those active in commerce—and their business was adversely affected by the turmoil of early 1773, then this could explain changes in haircuts. To control for this, we interact observable lender characteristics such as occupation, status or gender with the post-event dummy. The estimates are presented in Table 12. All estimates include lender and borrower type dummies (coefficients unreported). Estimated separately, we find that merchants lent at somewhat higher haircuts after 1772, while noblemen become willing to extend larger loans backed with the same amount of collateral; there is no significant interaction effect between the *Post 1772* dummy and the patrician, gender, and specialist dummies. In column 6 we estimate the impact of these interaction effects jointly. Crucially, the interaction term (*Exposed* × *Post* 1772) is virtually the same as in the benchmark estimates of Table 6 (comparable estimates are in panel A, column 2: 6.6 percent) and slightly increases in the full specification of column 6.

E. *Attrition*

In a previous section we documented that exposed lenders were less likely to exit the sample after Christmas 1772 than unexposed lenders. Different rates of attrition could introduce selection bias in the haircut regressions. To test this, we do

Table 12—Haircuts and Lender Characteristics

Lender type	M (1)	P (2)	N (3)	F (4)	S (5)	All (6)
Exposed	−0.002	−0.003	−0.003	−0.003	−0.003	−0.003
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)
Exposed × *Post 1772*	0.062	0.068	0.062	0.064	0.065	0.061
	(0.021)	(0.023)	(0.023)	(0.022)	(0.023)	(0.021)
Non-EIC	−0.055	−0.056	−0.056	−0.056	−0.056	−0.056
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Lender type × *Post 1772*	0.033	−0.015	−0.040	−0.026	0.005	
	(0.019)	(0.017)	(0.019)	(0.029)	(0.047)	
Constant	0.241	0.243	0.239	0.244	0.245	0.239
	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)
Year dummies	Y	Y	Y	Y	Y	Y
Lender type dummies	Y	Y	Y	Y	Y	Y
Borrower type dummies	Y	Y	Y	Y	Y	Y
Observations	387	387	387	387	387	387
Adjusted R^2	0.448	0.442	0.452	0.443	0.440	0.453
Lenders	152	152	152	152	152	152

Notes: Dependent variable: haircuts. Pooled OLS estimates for all English securities. Observations refer to new contracts and are weighted by the face value of the collateral. Haircuts are calculated as the fraction of the collateral value that is not financed with a loan. Exposed lenders are those who were forced to liquidate collateral after the events of Christmas 1772. The interaction between the *Exposed* and the *Post 1772* dummies captures the difference-in-differences effect. Lender and borrower type dummies are as in Table 3. Lender types: M(erchant): active in commerce; (P)atrician: member of (local) government or judiciary; N(oble), F(emale), (S)pecialist: lenders also active as borrower. Column 6 contains interactions with all lender groups. Robust standard errors (clustered at the lender level) are reported in parentheses.

two things. First, following Mulligan and Rubinstein (2008), we study whether the differential increase in haircuts is robust to the exclusion of those lenders that were more likely to exit the sample. We first estimate a probit model predicting whether a lender will stay in the sample, including the *Exposed* dummy, the total amount of lending before 1773, the relative exposure to the consortium and lender type dummies. We then rerun our regressions for lenders with progressively higher probabilities of staying in the sample, rerunning our baseline regression (column 2 of Table 6, panel A). The idea is that as we move closer to a sample that only includes lenders that are unlikely to exit the sample, we get closer to the unbiased coefficient estimate. Figure 4 presents the coefficients on *Exposed* × *Post* 1772 and its 95 percent confidence intervals. Overall, the coefficients do not vary significantly over the percentile range; if anything, they seem to increase. This suggests that sample attrition does not bias our coefficient upward.

F. *Unobservables*

Other unobservables could drive our results. While lenders exposed and unexposed to the Seppenwolde syndicate are broadly similar in many dimensions, it is possible that an unobserved, underlying factor is responsible for differences in risk appetite. To examine the possible empirical relevance of this issue we implement two additional tests.

First, we study the intensive margin of adjustment. If exposed and non-exposed lenders differ on unobservables, it is likely that there are also unobservable

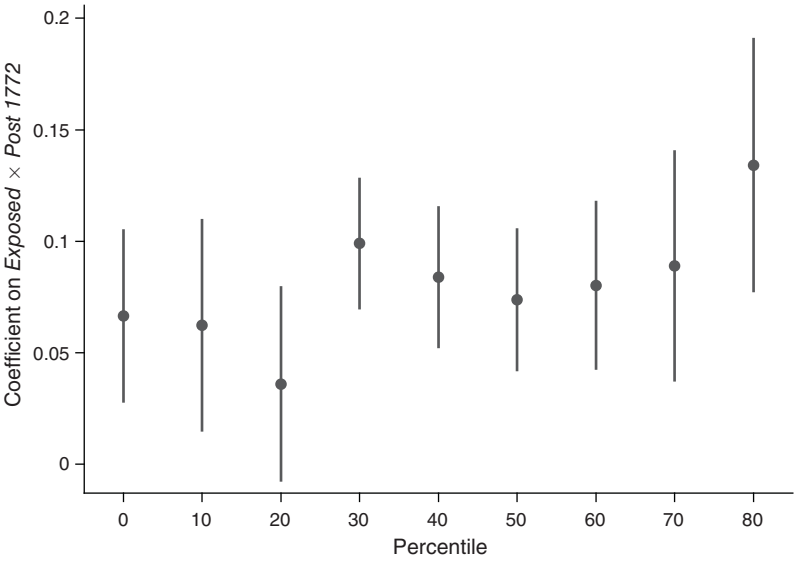

FIGURE 4. IMPACT OF ATTRITION

Notes: This figure documents the impact of attrition following Mulligan and Rubinstein (2008). We first run a probit predicting whether a lender will remain in the sample (see text for details). We then estimate the model of Table 6, panel A, column 2 excluding lenders with probabilities of staying in the sample below the *x*th percentile. The plot presents point estimates and 95 percent confidence intervals.

differences between lenders who lent relatively small or large amounts to the consortium. We test this in online Appendix Table B.6. Results indicate that lenders who, either in absolute or relative terms, lent more to the consortium did not change haircuts differentially compared to lenders who only provided relatively little credit. The interaction term with absolute exposure has a positive sign, but is statistically insignificant and economically small. A one standard deviation increase in the absolute position with the consortium around Christmas 1772 only raises haircuts by 1 percent. The interaction term with the relative exposure measure has a negative sign and is also statistically insignificant and economically small. A one standard deviation increase in the fraction of outstanding loans that were extended to the consortium decreases haircuts by 1 percent.

Second, we use the Altonji, Elder, and Taber (2005) method. We first estimate the interaction effect between the Seppenwolde exposure dummy and the *Post 1772* dummy, without controls. Then, we reestimate with controls, and examine the change in the interaction term. Assuming that unobservables are correlated with observables, this bounds their possible impact. If we use the EIC dummy and year fixed effects in the restricted model, and all categories of possible lenders and borrowers in the unrestricted model, we obtain an Altonji ratio of 6.7, meaning that the attenuating effect of unobservables would have to be at least 6.7 times stronger than the effect of observable variables before our results become insignificant.[40]

[40] If we estimate the restricted model without the EIC and year dummies, we actually obtain a negative result, implying that results get stronger as we add controls.

G. *Excluding the First Postcrisis Month*

When the Seppenwolde brothers went bankrupt, there was substantial uncertainty about the consequences for market prices. Several lenders received collateral after margin calls were not met. In addition, there was wide-spread concern in financial circles that only disappeared after the city's lender-of-last-resort facility opened in mid-January. To examine if our results simply reflect illiquidity and uncertainty during the immediate postcrisis period, we exclude all lending contracts signed in January 1773. This only marginally changes the results (online Appendix Table B.7): we still find an increase in the haircut charged by exposed lenders of 4–6 percentage points. This reduces sample size; combined with the fixed effect specifications, our results become (only borderline) statistically insignificant.

H. *Collapsing Data Pre- and Post-*1772

One well-known problem of difference-in-differences estimation is that standard errors can be understated, especially when the number of time periods is large relative to the number of units in the cross section. To investigate this issue, we collapse our data into two periods only: pre- and post-1772, as suggested by Bertrand, Duflo, and Mullainathan (2004). Online Appendix Table B.8 reports the results. If anything, the significance and size of the coefficient of interest increases, indicating that our panel analysis is not suffering from artificially small standard errors.

VI. Conclusion

> *One can only hope that reality will become more fashionable now* [*that*] *people are learning their lessons.*
>
> —*De Koopman* (January 1773, p. 310)

Investor heterogeneity has important implications for asset pricing (Harrison and Kreps 1978; Heaton and Lucas 1995; Hong and Stein 2007). It may contribute to momentum, elevated trading volume, high volatility, and the formation of bubbles (Hong, Scheinkman, and Xiong 2006). In addition, it can have a first-order impact on leverage in the economy. This has direct consequences for asset prices and for the amplification of shocks through the financial sector (Fostel and Geanakoplos 2008; He and Krishnamurthy 2013). How different beliefs among investors arise is less clear. Recent research suggests that personal experiences may be an important source of heterogeneity (Guiso, Sapienza, and Zingales 2013; Malmendier and Nagel 2011, 2016).

In this paper, we examine a well-identified case of large and long-lasting changes in major market participants' behavior. We analyze lenders who financed the equity positions of speculators in eighteenth century Amsterdam. Some of them were at risk of losing money when a syndicate of speculators went bankrupt; margin calls went unanswered, and collateral had to be sold. The episode could have spelled heavy losses. In actual fact, exposed lenders recovered all of their principal and interest. Nonetheless, those who almost lost money sharply increased their collateral requirements in all future transactions. Lenders unaffected by the bankruptcy

largely continued to lend as before despite the fact that distress was observed by all participants. Overall leverage declined sharply.

Modern financial markets do not function exactly like the eighteenth century Amsterdam stock market, but there are important similarities. Collateralized lending continues to be a key feature of securities markets, and changes in leverage can have important consequences. Search-and-matching also continues to be important—repo contracts are negotiated in OTC markets, for example. One important difference limits comparisons with the present, but aids identification: financial intermediation played no role in eighteenth century Amsterdam, whereas many of today's key players are intermediaries. The fact that lending was strongly procyclical in the past, even without obvious incentive distortions due to agency problems, strongly suggests that changes to personal risk-taking can drive changes in aggregate leverage.

We cannot determine exactly what caused the differential change in behavior. It was public knowledge that East India stock was more volatile, and returns more often negative, after 1771, and the ill fortune of the Seppenwolde syndicate was widely known. Nonetheless, only investors who almost lost money changed their behavior. The salience of (potential) losses is one possible interpretation.[41] Alternatively, exposed lenders could have learnt about their own ability to screen for investors able to meet margin calls. Yet another possibility is that exposed lenders rationally updated their beliefs, while unexposed lenders attributed their superior performance to their own skill.[42] All three channels would have lead exposed Seppenwolde lenders' beliefs to change more than those of unexposed lenders.

Strikingly, haircuts for exposed and non-exposed lenders converge only slowly in the years after 1772. Our results strongly suggest that individual risk-taking can change substantially as a result of personal experience, even without changes to wealth—and that such changes do not only arise among retail investors (Malmendier and Nagel 2011), but among sophisticated market participants as well. Importantly, we also show that personal experience can change investor behavior in a major way, causing significant shifts in aggregate outcomes such as market-wide leverage.

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[41] For an analysis of the effects of salience on risk-taking, cf. Gennaioli and Shleifer (2010).

[42] These interpretations are observationally equivalent, except for the fact that the unaffected lenders shifted the composition of their lending toward more risky assets (Table 4).

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